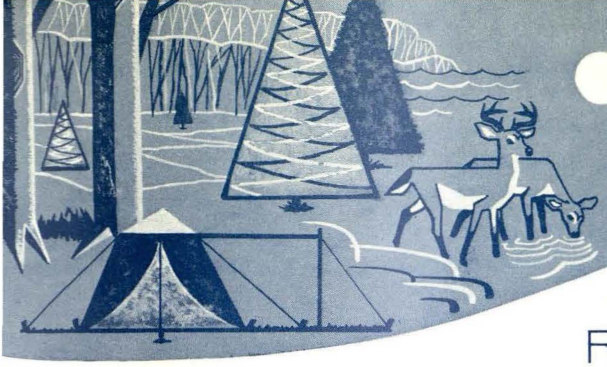

U. S. FOREST SERVICE

RESEARCH NOTE NC-105

NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE

Folwell Avenue, St. Paul, Minnesota 55101

EARLY GROWTH OF BLACK WALNUT TREES FROM TWENTY SEED SOURCES

ABSTRACT. — Early results of a black walnut seed source study conducted in southern Illinois suggest that seed should be collected from local or south-of-local areas. Trees from southern sources grew faster and longer than trees from northern sources. Trees from southern sources flushed slightly earlier and held their leaves longer than trees from northern sources. For the 1969 season, height growth rate was best explained by the rainfall pattern. Diameter growth rate was more closely related to air and soil temperatures than to rainfall and soil moisture.

OXFORD: 181.65:176.1 *Juglans nigra* (773): 181.8:165.3

Black walnut (*Juglans nigra* L.) seed and seedlings are being planted throughout the eastern United States. Although general seed collection zones have been suggested (Limstrom 1963), little information is available on performance and growth pattern (Bey 1968, Bey and Phares 1969). Walnut is a variable species and origin of seed should be a prime consideration for landowners, nurserymen, and others concerned with walnut improvement.

METHODS

In 1967, we planted 1-year-old seedlings from 20 sources of black walnut in southern Illinois (Alexander County) at a latitude of 37.3° N. The planting, consisting of a randomized complete block design with six replicates of four-tree plots, is on a deep, alluvial, silt loam soil, which is considered excellent for walnut. We controlled weeds in the plantation for 3 years using simazine and atrazine and pruned the trees each year (Krajicek and Bey 1969).

During the spring and summer of 1969 (the fourth growing season from seed), we collected data on leaf flush, leaf fall, height growth, diameter growth at 15 cm., rainfall, air and soil temperature, and soil moisture (Toliver 1970). For convenience in describing the growth pattern during 1969, seedlings from the 20 sources were placed in five groups by 2° intervals of latitude – South, Mid-south, Mid, Mid-North and North. The grouping was strictly arbitrary; there is no evidence of natural segregation into groups. All evidence indicates the pattern of variation is clinal.

RESULTS

After 4 years, trees from southern sources were generally taller and larger in diameter than trees from local and northern sources (table 1). The variation appears to be clinal in a north-to-south direction. Straight-line regressions for height and diameter over latitude for 1968 and 1969 were highly significant (fig. 1). About 40 percent of the variation for height and 25 percent of the variation for diameter were associated with latitude. All correlation coefficients were significant. The slopes of the regression lines

Table 1.—Black walnut seed sources and growth duration of seedlings planted in southern Illinois

State and group	North lat. : degrees	Total days of growth during 1969 season : Height	: Diameter
Tex.	31.6	134	123
Miss.	32.2	134	123
South average	31.9	134	123
Miss.	34.0	119	116
Ark.	35.0	119	123
Tenn.	35.2	127	123
N.C.	35.4	105	116
N.C.	35.5	127	109
Ark.	35.8	105	116
Mid-south average	35.1	117	117
N.C.	36.0	98	116
Tenn.	36.3	98	116
Ky.	37.0	127	116
Ill.	37.4	105	123
Ky.	37.6	105	116
Va.	37.7	112	109
Mid average	37.0	108	116
Ind.	38.2	105	109
Mo.	38.3	112	123
Ind.	39.0	98	116
Mid-north average	38.5	105	116
Ill.	41.4	98	116
Iowa	41.5	91	123
Iowa	42.3	91	109
North average	41.7	93	116

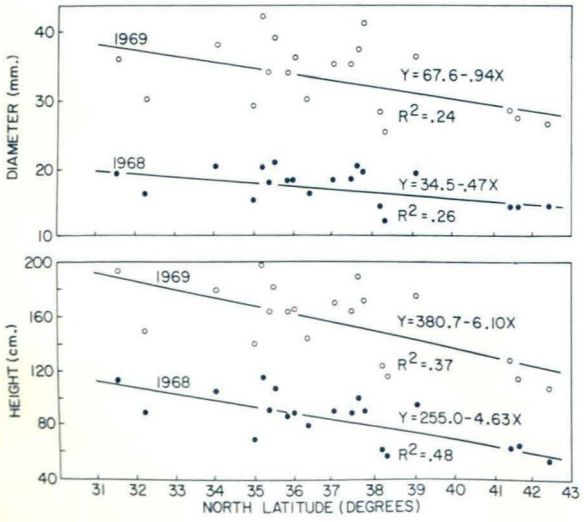

Figure 1.—Relation between growth and latitude for trees from 20 sources of black walnut.

for both height and diameter increased from 1968 to 1969, indicating that trees from the southern sources increased their height and diameter superiority over the trees from the northern sources.

During the 1969 growing season, trees from the southern sources grew faster and longer than the trees from the northern sources. Height growth started about 3 days earlier in the southern sources and continued about 2 weeks longer. Height growth lasted for 134 days in the South group, compared with 93 in the North group. Ninety percent of the height growth was completed by July 7 for the North group, compared with July 22 for the South group.

Duration of diameter growth was less closely related to latitude than duration of height growth. There was no strong north-south trend for number of days of diameter growth, nor for date by which 90 percent of the diameter growth had occurred. Diameter growth started about 3 days earlier for trees in the southern sources, but stopped at the same time for trees in all sources. However, trees in the southern sources grew faster than trees in the northern sources. The differences among the groups gradually increased throughout the growing season.

The growth pattern for all groups was similar but not identical. The overall pattern was a sigmoid curve. The increase in growth rate (for height) in mid-July is best explained by the pattern of rainfall and soil moisture[1] (fig 2). The reduction in growth rate in mid- and late June occurred after a period of little rain. About 1 week after a heavy rain (the first week of July), the growth rate of all sources increased. However, the rate of increase for the North group was less than half that for all other groups. Although all groups responded to the increased moisture in early July, there was no increase in growth with additional rain in late July and early August. It appears that after a certain stage of development, additional water will not stimulate height growth.

The growth pattern for diameter was not bimodal, as it was for height. The pattern was more closely related to maximum and minimum

[1] *Field capacity was determined from a bulk sample representing the 8-69 cm. depth in the soil profile.*

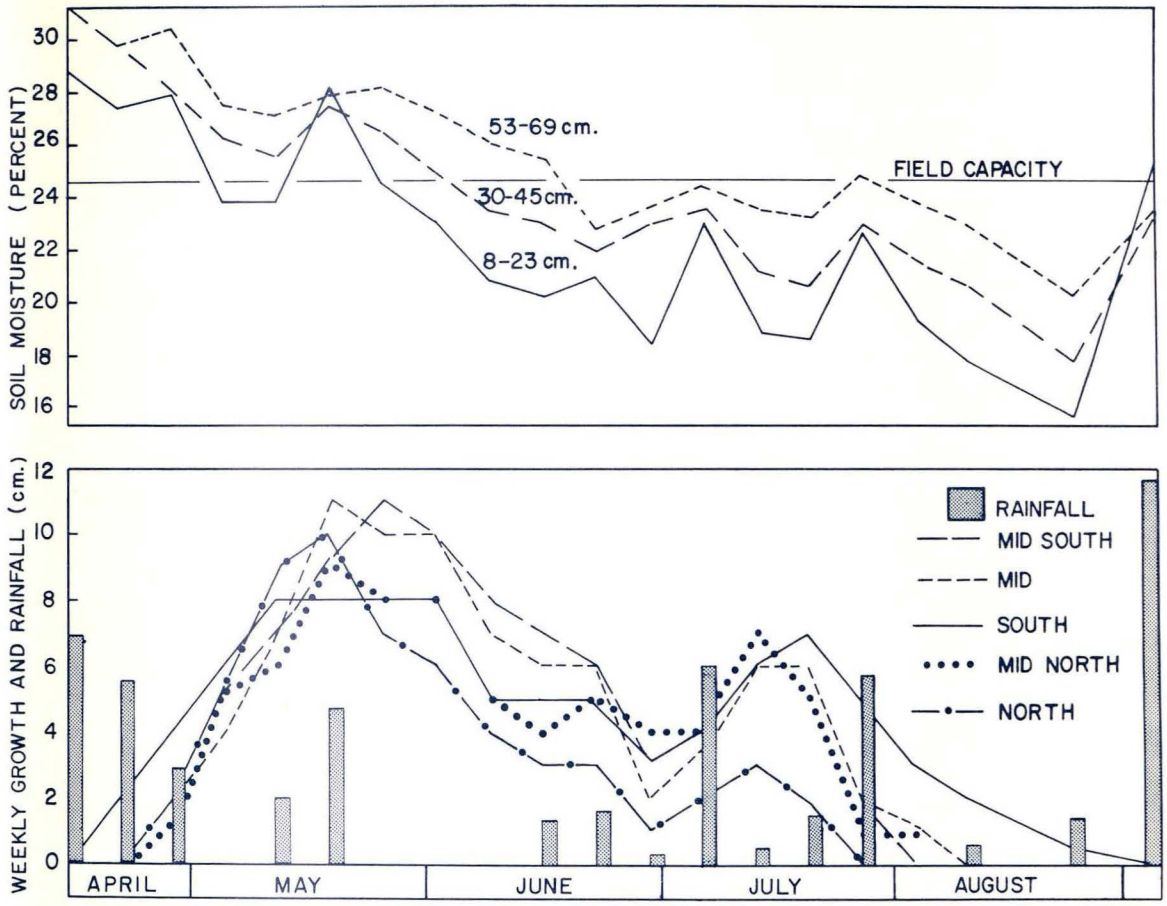

Figure 2.—Relation between weekly height growth, rainfall, and soil moisture for trees from 20 sources (five groups) of black walnut.

air and soil temperature than to rainfall and soil moisture. Diameter growth rate for trees from all sources gradually increased until July 21 and then gradually decreased. Maximum and minimum air and soil temperatures gradually increased until the last week of June, remained about constant for 3 weeks, and then gradually decreased.

Trees from southern sources flushed earlier than those from local sources. The straight-line regression for date of leaf flush over latitude ($y = -6.0 + .90x$) was highly significant (fig. 3). Forty-two percent of the variation in date of leaf flush was associated with latitude. The equation indicates that flushing is delayed 1 day for every 63 miles north of the planting site that seed is collected. For a state 250 miles

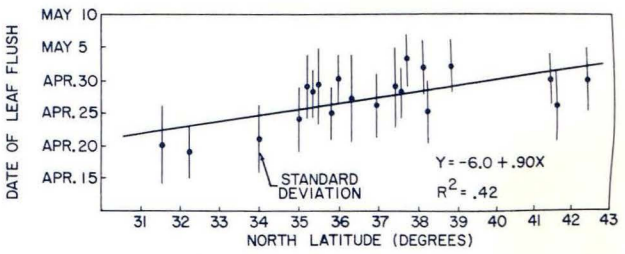

Figure 3.—Relation between date of leaf flush and latitude for trees from 20 sources of black walnut.

north to south, the maximum gain (by collecting northern seed and planting it in the south) would be about 4 days. However, for flushing date the average standard deviation within sources (for the six replicates) was 5 days. It

appears that selection within sources could lead to considerable gain in late-flushing types.

Selection for late-flushing types should be considered in a tree-improvement program. Although there was no late frost in 1969, many trees in this experiment flushed before the chance of frost was over. The mean date of the last 32° F. freeze in spring for the area of the planting is April 5 (Joos 1960).

Trees from northern sources of walnut dropped their leaves earlier than those from southern sources (fig. 4). The straight-line regression for date of leaf fall over latitude ($y = 146.6 - 2.48x$) was significant (fig. 4).

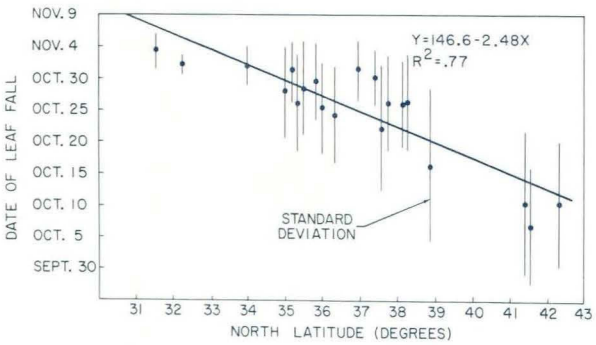

Figure 4.—Relation between date of leaf fall and latitude for trees from 20 sources of black walnut.

Seventy-seven percent of the variation in date of leaf fall was associated with latitude. Most of the trees from the sources south of the planting site held their leaves until after a moderate freeze (27° F.)[2] on October 28. The mean date for the first 28° F. freeze in the fall for the area is November 14. Had the freeze not occurred until the mean date (November 14), the southern sources would have likely held their leaves longer and the slope of the curve would have been steeper.

The period between terminal growth cessation and leaf fall was 9 to 13 weeks for all sources. There was no apparent pattern. The five group averages, from north to south, were 10, 11, 11, 11, and 10 weeks. These data appear to indicate the degree of maturity of the buds and stems. After a very cold winter in 1969-1970 (average low temperature, 8° below normal), there was no evidence of winterkill to any buds or stems. However, severe winter weather in the future may still cause some mortality.

These early results suggest that walnut seed should be collected from local or south-of-local areas. Although there was no problem of winterhardiness in southern Illinois during the first 3 years, we feel that the movement of seed north should be limited to 150 miles. Tests from this and other outplantings will give a more complete answer at a later date.

[2] *Recorded by Weather Bureau at Cape Girardeau, Missouri, 12 miles west of planting site (U.S. Department of Commerce 1969).*

LITERATURE CITED

Bey, C. F. 1968. Genotypic variation and selection in *Juglans nigra* L. Ph. D. thesis on file at Iowa State Univ. 87 p.

Bey, C. F. and Phares, R. E. 1969. Seasonal growth pattern for five sources of black walnut. Proc. Cent. States Forest Tree Impr. Conf. 6: 44-47.

Joos, L. A. 1960. Freeze probabilities in Illinois. Univ. of Ill. Agr. Exp. Sta. Bull. 650, 16 p.

Krajicek, J. E. and Bey, C. F. 1969. How to "train" black walnut seedlings. USDA Forest Serv., N. Cent. Forest Exp. Sta. Leafl.

Limstrom, G. A. 1963. Proposed seed collection zones for the Central States. Proc. Cent. States Forest Tree Impr. Conf. 3: 31-39.

Toliver, J. R. 1970. Genotypic variation in black walnut (*Juglans nigra* L.)—growth patterns for 20 geographic sources. M.S. thesis on file at Southern Ill. Univ. 39 p.

U.S. Department of Commerce. 1969. Climatological data, Illinois, October 1969. 74(10): 121-131.

CALVIN F. BEY
Plant Geneticist
Forestry Sciences Laboratory
Carbondale, Illinois (field office maintained in cooperation with Southern Illinois University)
JOHN R. TOLIVER
Former Graduate Student
Southern Illinois University
PAUL L. ROTH
Assistant Professor
Department of Forestry
Southern Illinois University

1971